



ICFA-HB2002 April 8-12, 2002, Fermilab, USA

3GeV RCS at the JKJ

20th ICFA Advanced Beam Dynamics Workshop
on High Intensity and High Brightness Hadron Beams
on
April 9, 2002
at
Fermilab, Batavia, IL

presented by
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Presentation Outline



Outline of 3GeV RCS at the JKJ

Accelerator complex

Pulse structures and beam sharing

Schedule

Overview of 3GeV RCS

Key issues and R&D status

-Injection system

-Collimator system

-RF system

-Vacuum chamber

Beam loss estimation

Tunnel and building

Summary and Plans for Future Work

Accelerator complex



3-GeV rapid-cycling synchrotron

extracted beam power is 1MW
at a repetition rate of 25Hz.

400-MeV
normal-conducting Linac

3 GeV PS

Transmutation System

Linac

to Super-KAMIOKANDE

Material and life science facility

50 GeV PS

Nuclear&Particle Physics Facility

Material & Life Science Facility

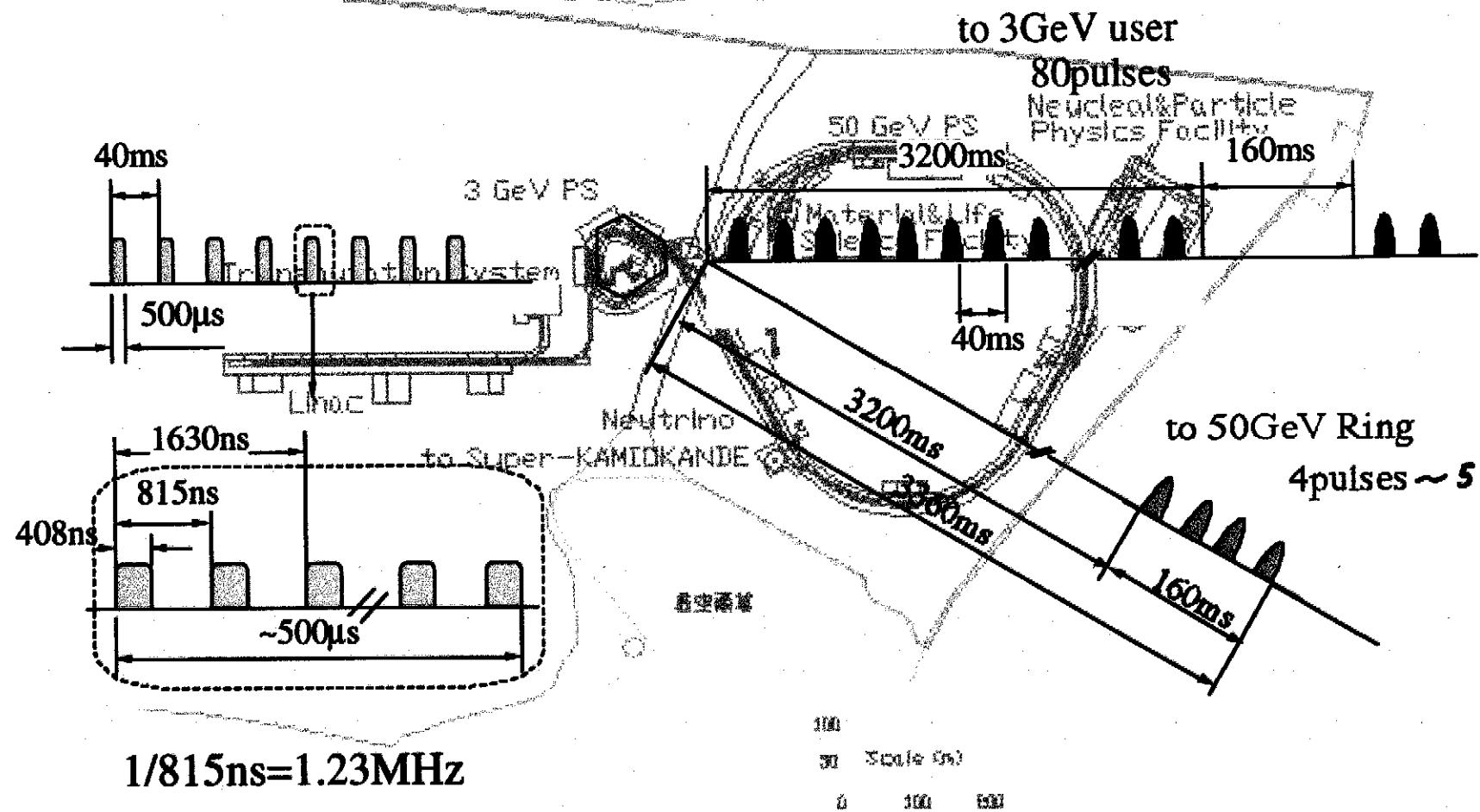
50-GeV synchrotron



Pulse structures and beam sharing

Injection pulse structure

Extraction pulse structure Beam sharing

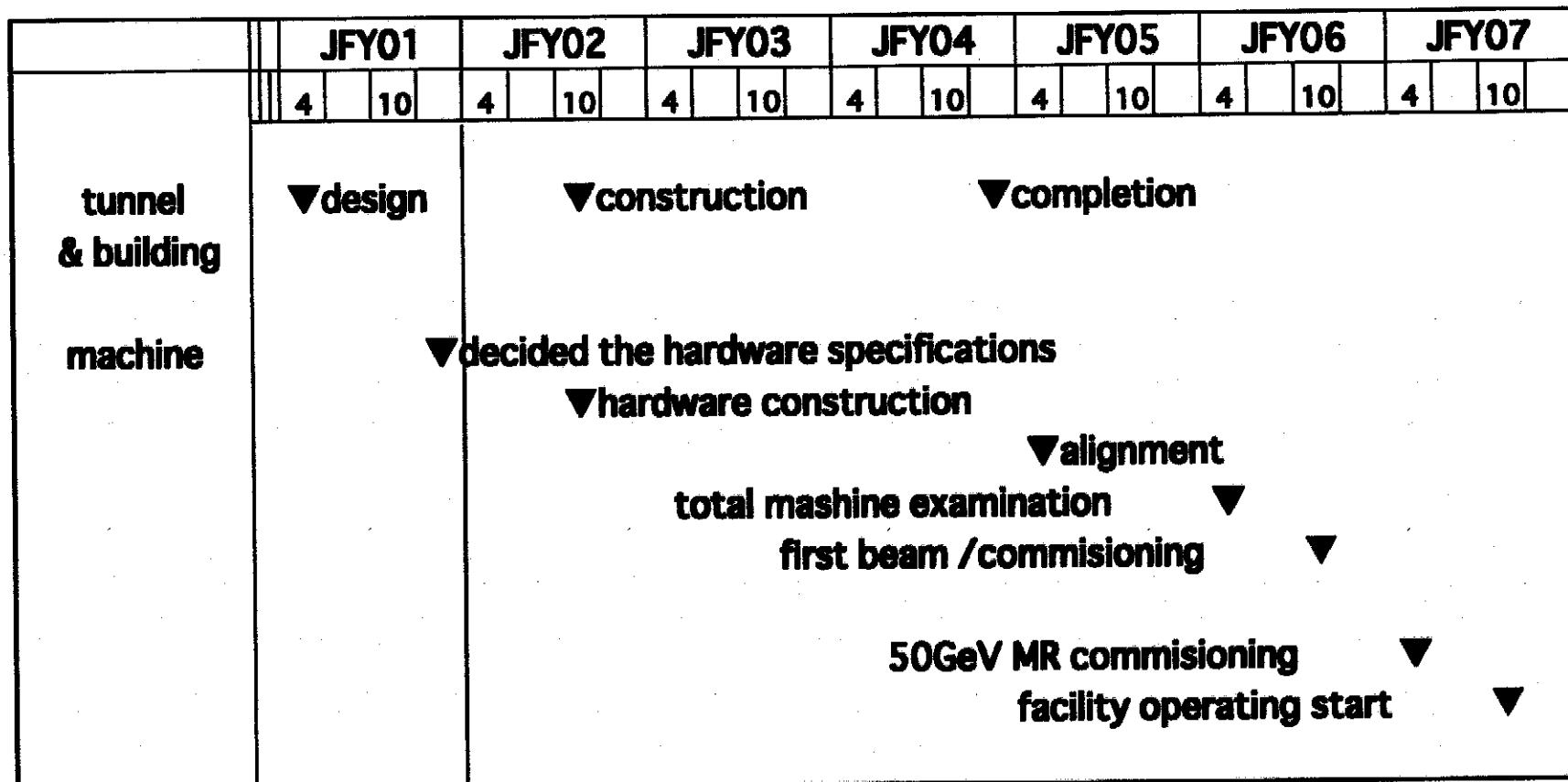


Schedule

Tunnel and hardware construction starting in October, 2002

The hardware alignment starting in April, 2005

First beam in October, 2006



Schematic view of 3GeV RCS

Circumference

348.333m

Injection energy

400MeV

Extraction energy

3GeV

Repetition cycle

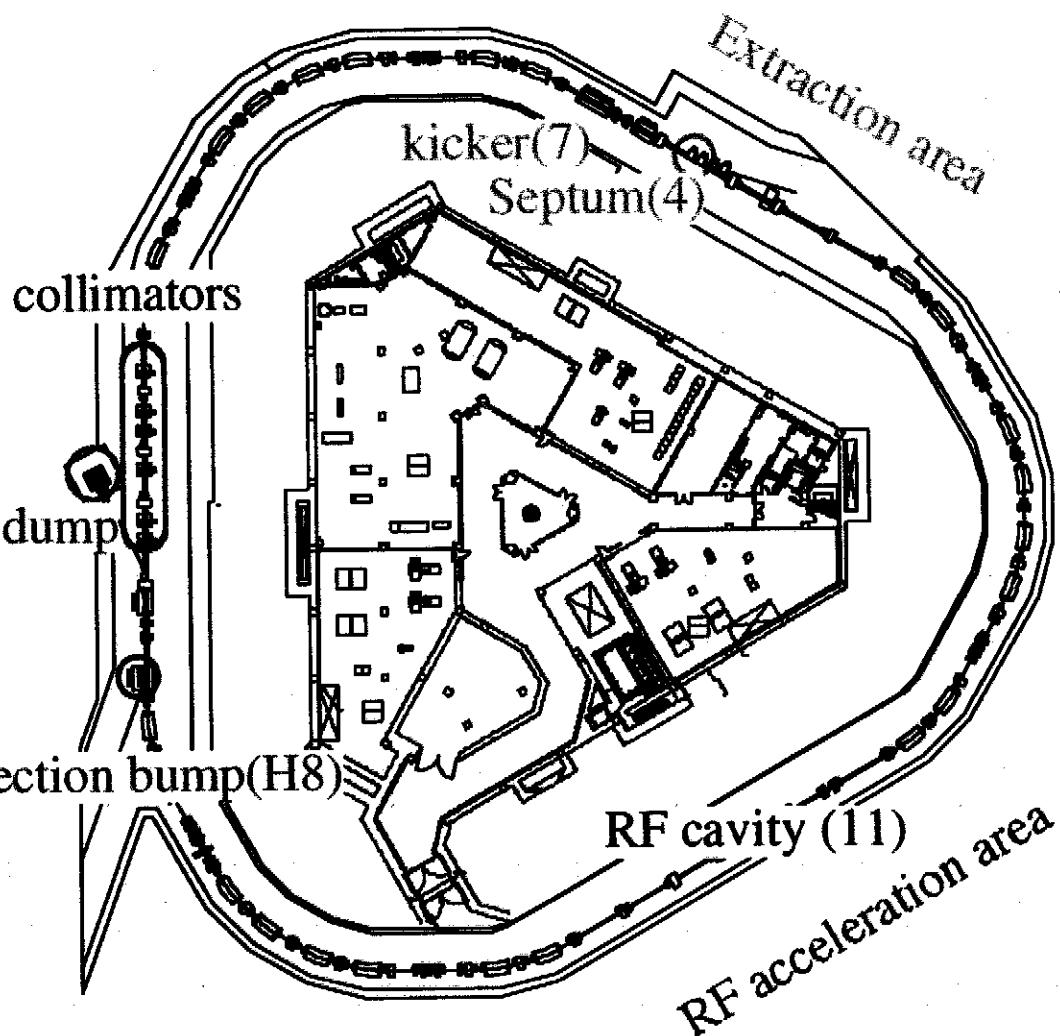
25Hz

Beam Power

1MW

Beam loss is
serious problem

Injection/Collimation area



Key issues of 3GeV RCS



Beam loss control

***Injection system(painting system)**

Charge exchange foil and auto changer

***Collimation system (localization of beam loss)**

Remote handling system(high radiation area)

Large aperture magnets(B,Q,S,inj. and ext. magnets)

***RF acceleration system**

Large aperture monitors

***Vacuum chamber**

Beam tracking with error, fringe field, space-charge and etc

Injection system

Space-charge reduction and Beam loss control

H⁻ injection

charge exchange foil and auto changer

Painting injection ($4\pi \text{mm.mrad} \rightarrow 216\pi \text{mm.mrad}$)

Horizontal :shift bump + painting bump (x and x')

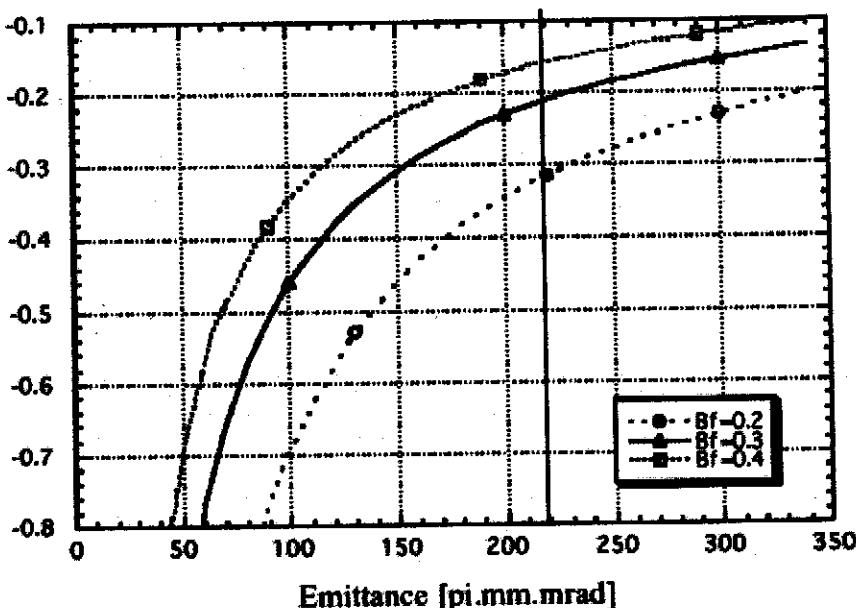
Vertical : π bump (y')

rough estimation

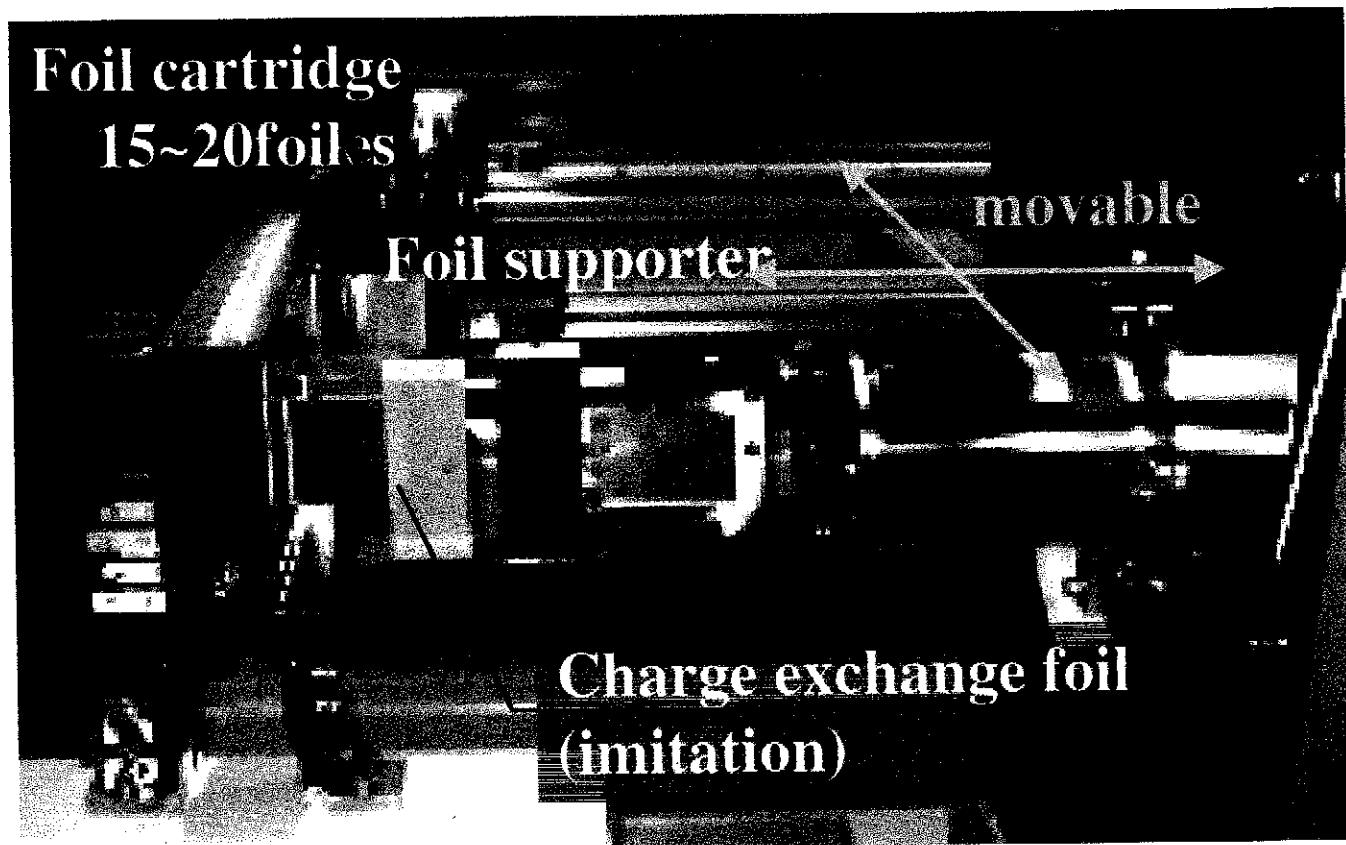
Used formula

$$\Delta v = -\frac{r_p n_t}{2\pi\beta^2\gamma^3 e B_f},$$

H⁰ beam dump



R&D : foil changer



Heat and strength calculation of carbon foil ongoing
Development of long life carbon foil ongoing

Collimation system

Beam loss control = Localization of beam loss

collimator area

:4kW

another area (circumference)

:1W/m for hand on maintenance

(injection and extraction area :1kW)

Adequate Physical aperture/collimation aperture ratio

estimation by STRUCT code which is developed in FNAL

Two stage collimation system
Primary collimator + secondary collimator

+

Dispersion free area RF Cavity

0 1m

R&D : beam collimator

Movable collimator

Allowable heat capacity: ~1kW per collimator

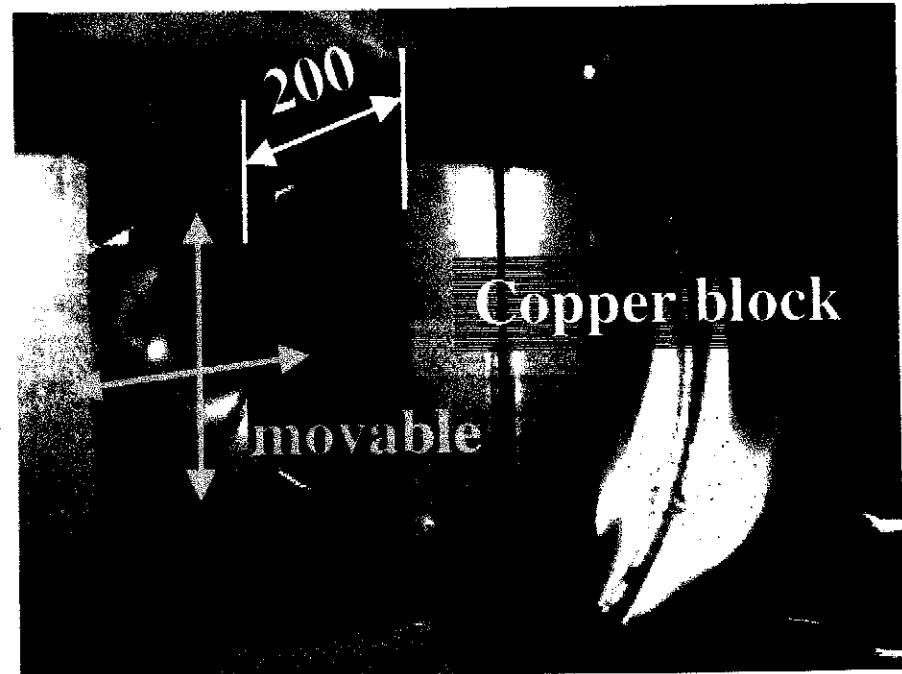
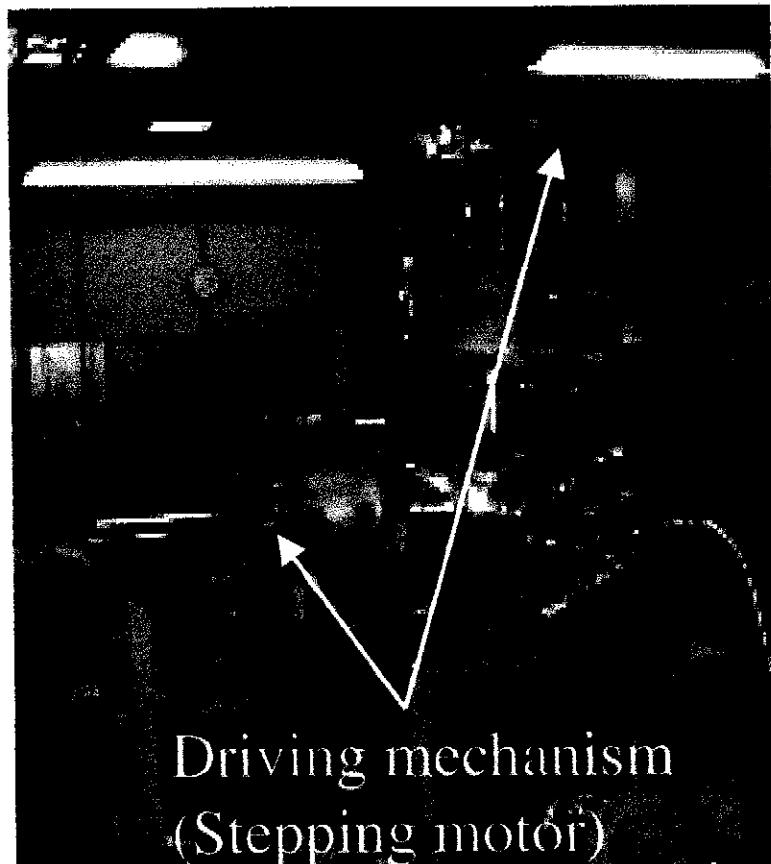
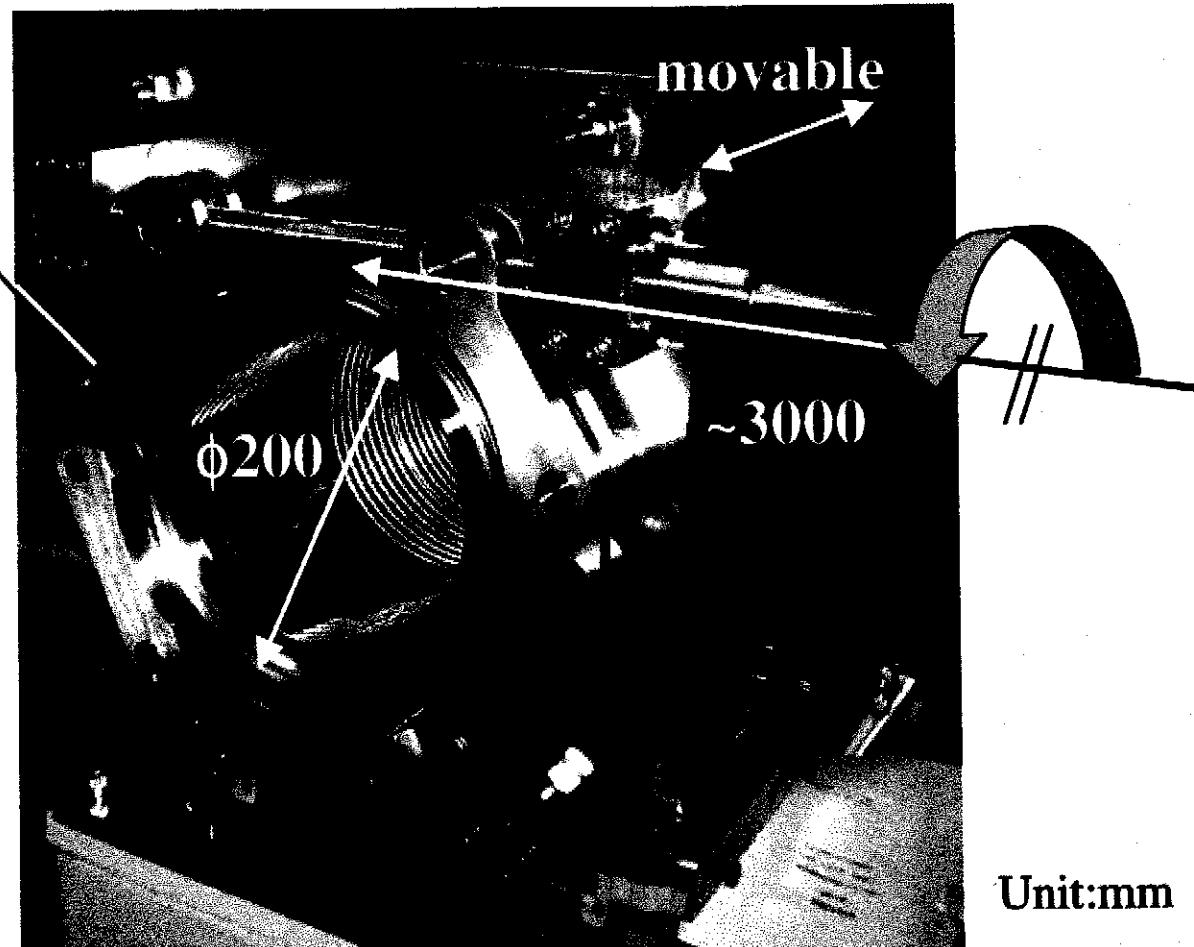


Photo of collimator(secondry)

R&D : remote handling mechanism

Quick coupling
stainless



Development of quick coupling
for a large aperture(~400mm) ongoing

RF acceleration system

Restraint of ring circumference space-charge reduction

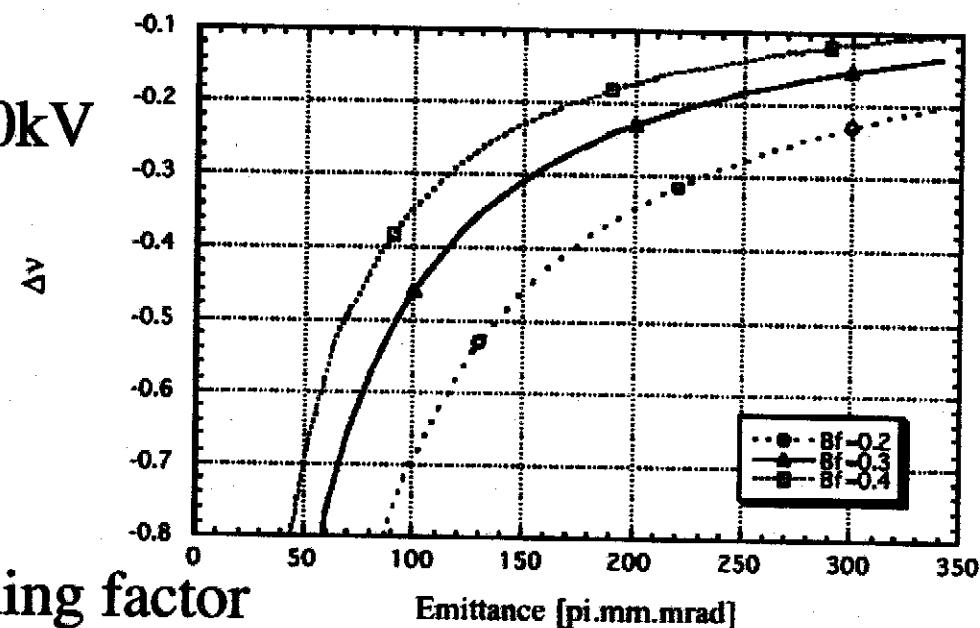
High gradient cavity
maximum voltage = 450kV
 $22\text{kV/m} \Rightarrow 20.5\text{m}$

low Q cavity
dual harmonic system
-improvement of bunching factor

$\text{dv}=0.213$ with basic harmonic ($\text{B.f.} \sim 0.3$)

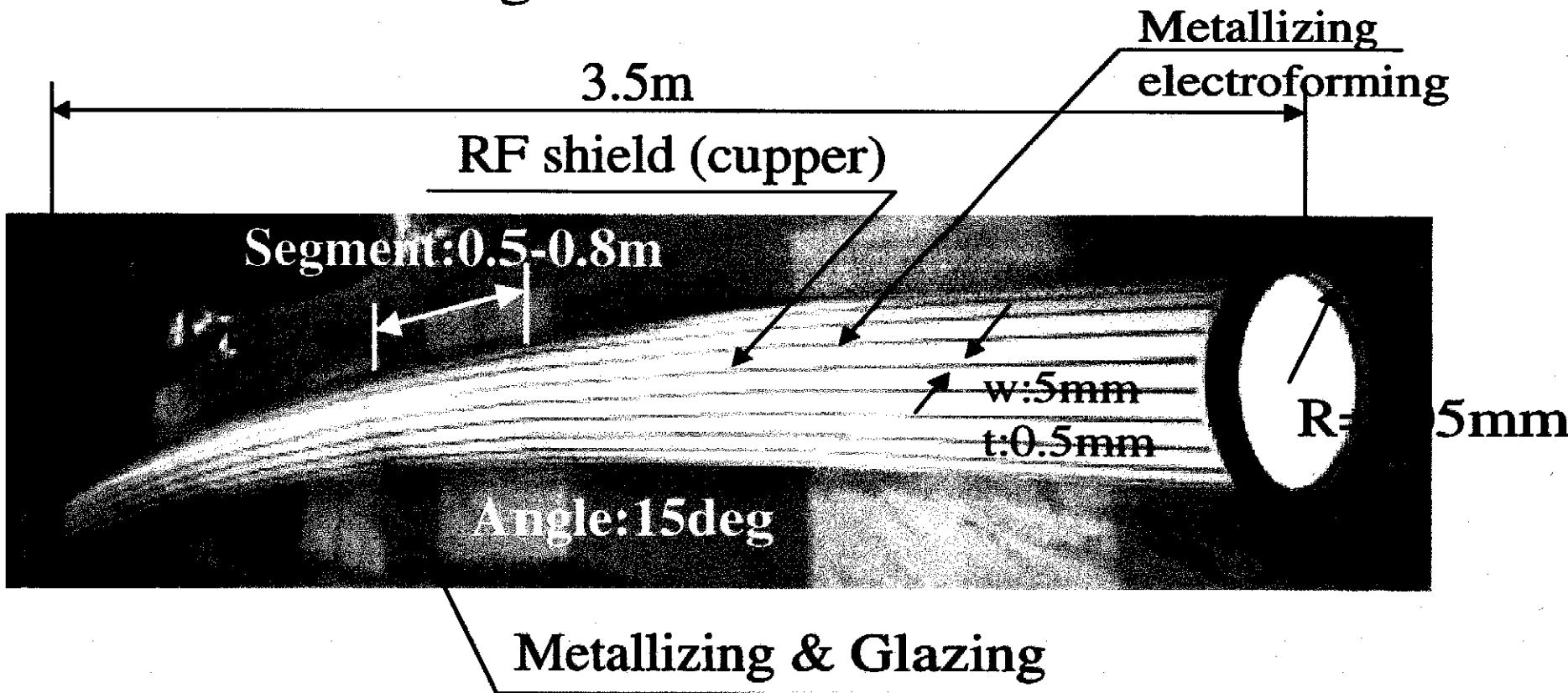
$\text{dv}=0.16$ with dual harmonics ($\text{B.f.} \sim 0.4$).

Now improved cavity is constructing



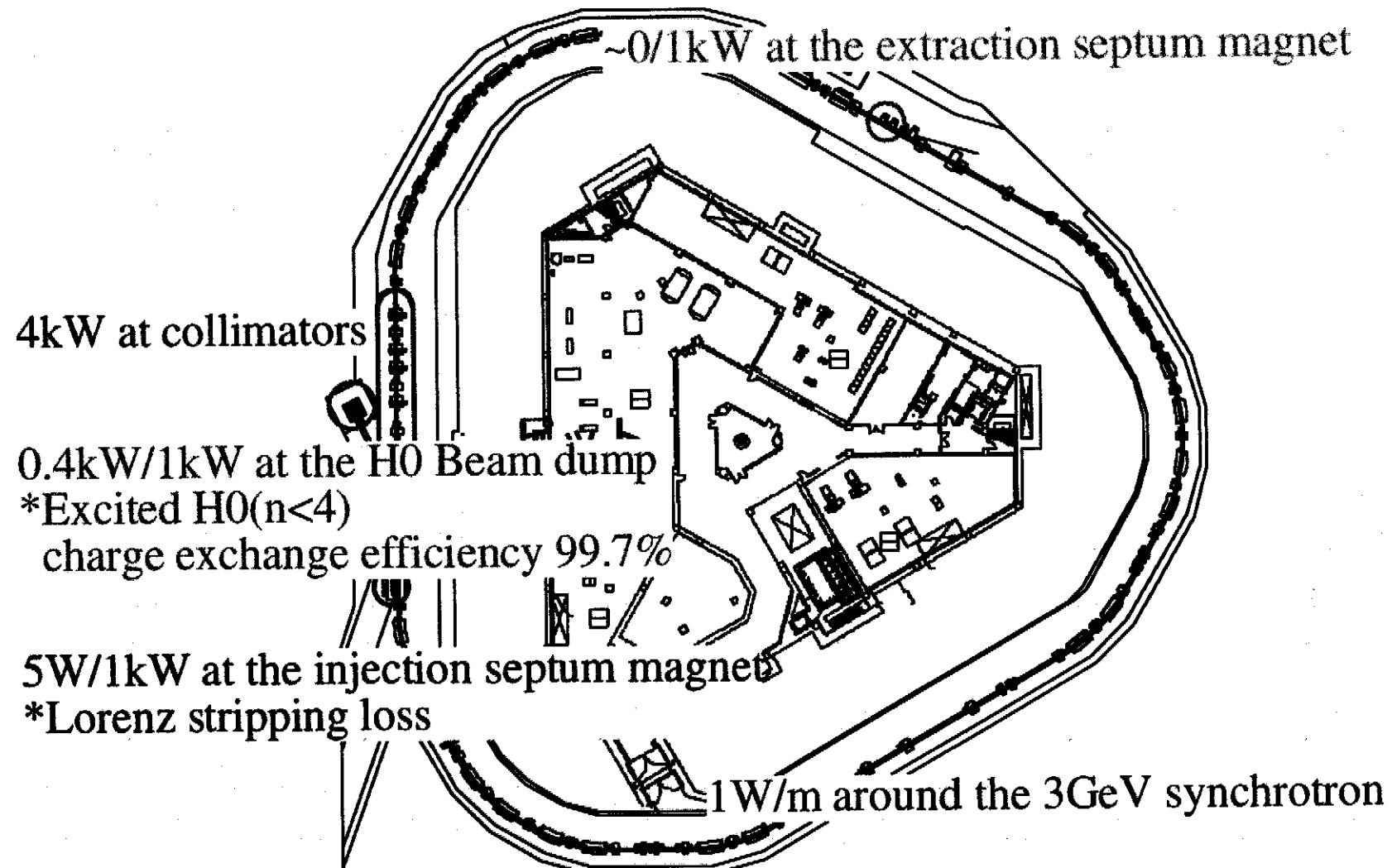
R&D : vacuum chamber

Long and large aperture ceramic chamber
with RF shield (and TiN coating(inner surface))
RF shield w:5mm, t:0.5m
TiN coating t:1-2nm





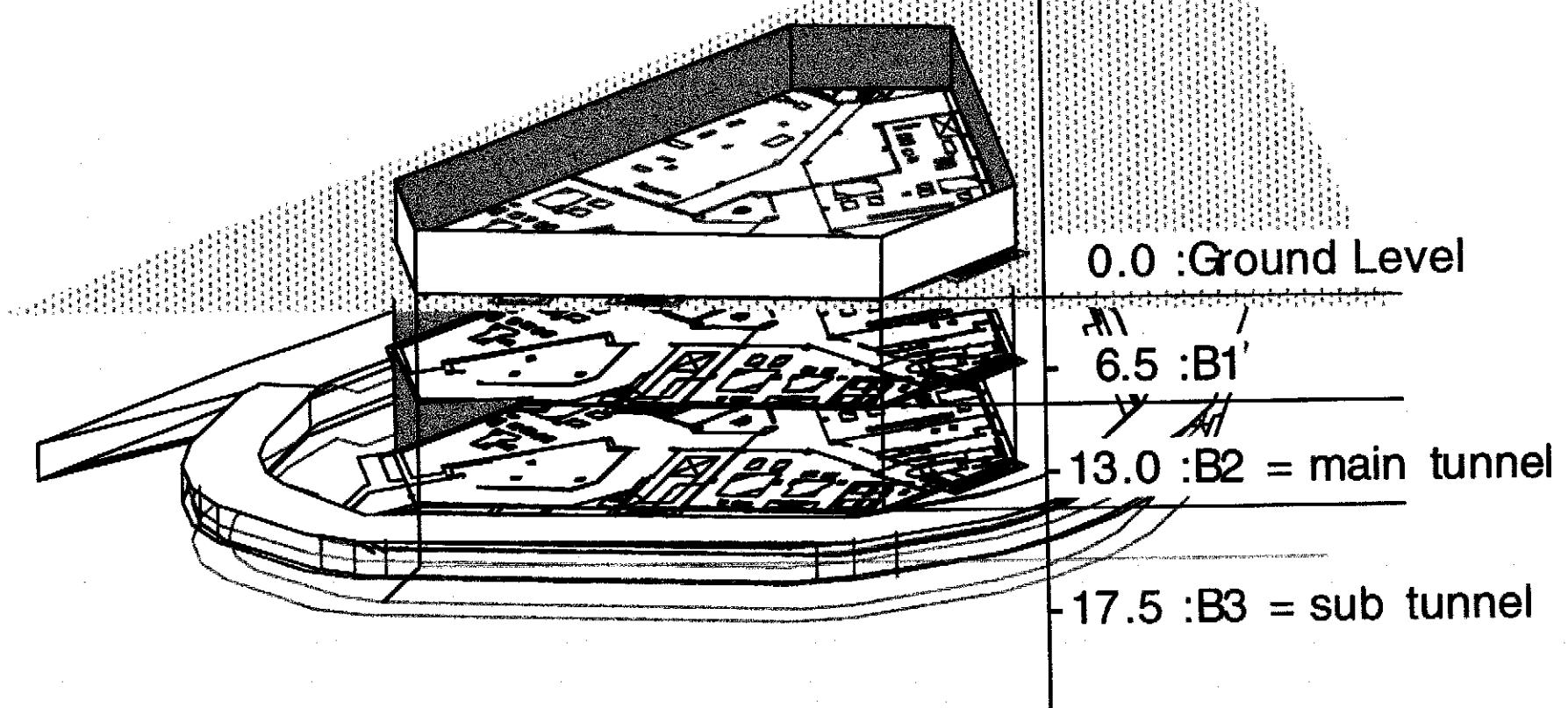
Beam loss estimation



Normal operation/ design for Machines and building



Tunnel & building(1)



GL : Power supplies of main magnets & Local control room

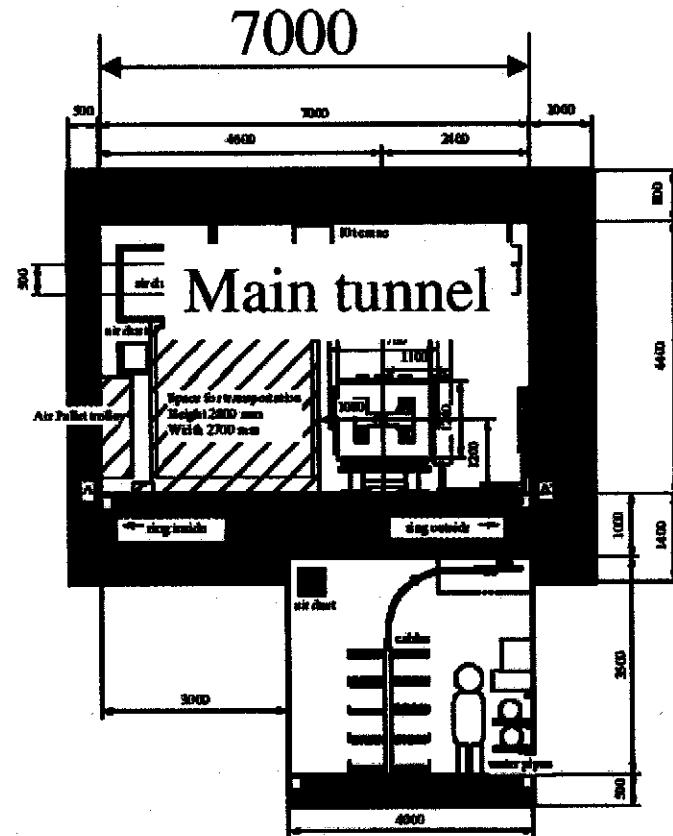
B1 : Power supplies of injection and extraction magnets

B1 : Utilities (water, air conditioning, ...)

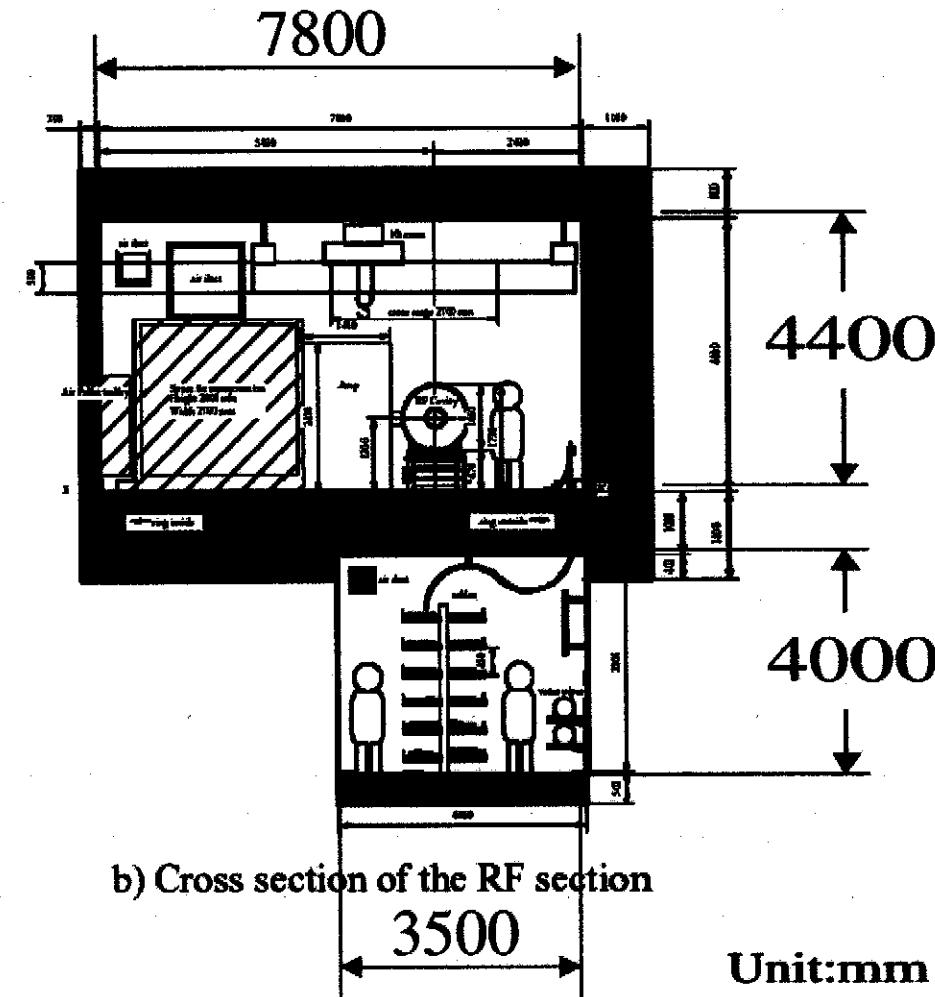
Tunnel&building(2)

Main tunnel : magnets, monitors, ...

Sub tunnel : cables, controllers, ...



a) Cross section of the arc section



Unit:mm

Summary

- lattice design basically fixed
- Last stage of R&D
 - feedback to hardware design and lattice design as needed
- Decision of hardware specifications ongoing
- detailed performance studies ongoing, *e.g.*
 - Beam tracking with space-charge, error, fringe field
 - Beam loss estimation